

DEGRADATION OF CHLORFENVINPHOS IN CONTAMINATED DRINKING WATER SYSTEMS BY FENTON'S OXIDATION

Cátia Oliveira, Mónica Santos, Arminda Alves, Miguel Madeira

LEPAE, Chemical Engineering Department, Faculty of Engineering, University of Porto

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

*Corresponding author: Tel. +351 22 508 1687. E-mail: aalves@fe.up.pt

INTRODUCTION

Chlorfenvinphos, 2-chloro-1 (2, 4- dichlorophenyl) vinyl diethyl phosphate (Figure 1), is an organophosphorus insecticide used in agriculture, in soils and foliage. When in contact with humans, it can affect many organs, and in large quantities it could be lethal. This compound presents a high solubility in water (145 mg/L) and could become a threat to public health. In order to avoid this problem, it becomes necessary to develop a method of degradation of the pesticide, namely by Fenton's reaction.

From a wide range of technologies for water treatment, one of the most common, efficient and clean is the chemical oxidation, in spite of his biodegradability being non guaranteed. Although there are several oxidation processes, this study was carried using oxidation by Fenton's reaction. This process efficiency is due to the generation of hydroxyl radicals ($\cdot\text{OH}$), with high oxidation power ($E_0 = 2,80 \text{ V}$), destroying, in a non selective way, the majority of the organic substances, according to the general reactions 1 and 2, described below.

Attending to this problematic, this work intends to evaluate the degradation of chlorfenvinphos through a parametric study of oxidation, according to the following reaction.

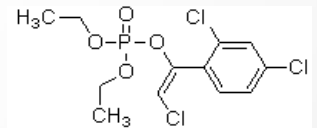
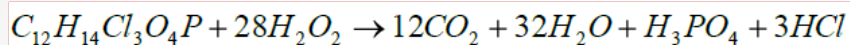
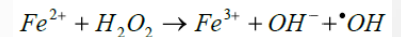
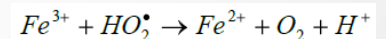


Figure 1: Structural formula of chlorfenvinphos (CLVP).

Reaction 1: Production of hydroxyl radicals.



Reaction 2: Regeneration of catalyst.



EXPERIMENTAL



Degradation of Chlorfenvinphos by Fenton oxidation - Batch Assays

Reaction time: 3 hours;
Initial volume of CFVP: 250 mL;
Initial CFVP concentration: 100 mg/L



TOC Analysis
(evaluation of the degree of CLVP mineralization)
Shirazu 5000-IA analyzer

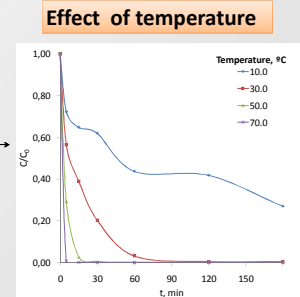
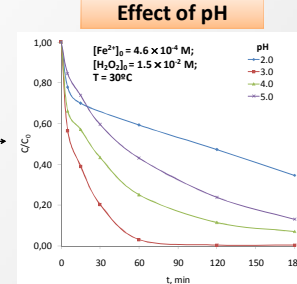
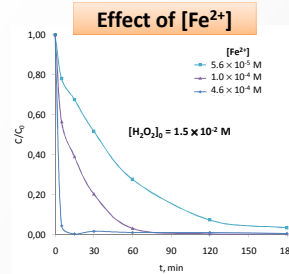
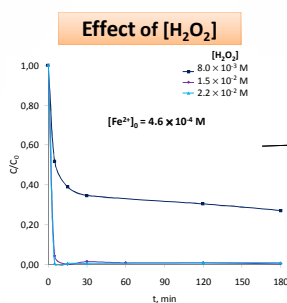


HPLC Analysis (quantification of CFVP after oxidation)

Injection volume: 20 μL ;
Mobile phase: 70% Acetonitrile, 30% Water;
Flow rate: 1 mL min^{-1} ;
Monitoring wavelength: 240 nm;
Retention time: $4,8 \pm 0,2$ minutes

RESULTS

Initial conditions
[CFVP] $_0$ = 100 mg/L;
pH = 3.0; T = 30°C



H_2O_2 $1.5 \times 10^{-2} \text{ M}$ provides a degree of degradation similar to that obtained with H_2O_2 $2.2 \times 10^{-2} \text{ M}$. However, in order to use less amount of oxidant agent, H_2O_2 $1.5 \times 10^{-2} \text{ M}$ was used in the following procedures.

Fe^{2+} $1.0 \times 10^{-4} \text{ M}$ was chosen in subsequent experiments because it provides a good degree of degradation, using less amount of catalyst.

pH 3.0 provides higher degradation rates.

As temperature increases, the degree of degradation increases

CONCLUSIONS

- Higher initial $[\text{H}_2\text{O}_2]$ \rightarrow higher initial $[\cdot\text{OH}]$ \rightarrow faster degradation;
- Higher initial $[\text{Fe}^{2+}]$ \rightarrow faster production of $\cdot\text{OH}$ \rightarrow faster degradation;
- pH < 3.0 \rightarrow excess of H^+ reacts with H_2O_2 (parallel reactions)
- pH > 3.0 \rightarrow slower degradation (lower stability of H_2O_2)
- As temperature increases, the degree of degradation increases (kinetic constant depends of temperature, following the Arrhenius's Law).
- The degradation includes two stages: the first one where Fe^{2+} reacts in a fast way with H_2O_2 , producing hydroxyl radicals; the second, much more slower, where occur the regeneration of Fe^{3+} to Fe^{2+} .

ACKNOWLEDGEMENTS

